3.9 HYDROLOGY AND WATER QUALITY

This section addresses potential changes to surface water, groundwater, and water quality from construction and operations.

3.9.1 Affected Environment

3.9.1.1 Lower Colorado River

Surface Water

The LCR has a wide variation in annual inflows of source waters, which is typical of river systems within semi-arid and arid climate zones. Historically, this natural variation resulted in wide variations in annual river flows. However, the development of dams and other facilities significantly modified this natural variation by storing water for controlled releases. Facilities on the river are operated primarily for flood control, water supply, and hydropower production. Agricultural, urban, and power generation demands and the associated dam releases to meet these demands lead to daily and monthly variations in flows. The volume and flow in the river affects water levels (stage), surface area, and salinity levels (USBR 2000b).

The Colorado River in its entirety is approximately 1,400 miles long. The proposed action has the potential to affect the hydrology from the full pool elevation of Lake Mead (approximately at Separation Canyon [RM 450] to the SIB [RM 0]). The river flow is highly variable from year to year. For example, the natural flow at the Lees Ferry gaging station has varied annually from 5 maf to 24 maf (USBR 2000b) (Figure 3.9-1). These flows show significant annual variability; however, the average trend over the past 40 years closely approximates the 15 maf total apportionment for the Upper and Lower Basin states. The Upper and Lower basins of the Colorado River are shown on Figure 3.9-2.

The size of the watershed and variability of the natural hydrologic system make managing the Colorado River a challenge. To better control and utilize waters of the Colorado River multiple dams, power plants, and diversion structures have been constructed, some dating as far back as 1860. Currently, the overall system has ten major reservoirs that provide an aggregate of approximately 60 maf of active storage.

Dams in the Lower Basin include Hoover, Davis, Parker, Headgate Rock, Palo Verde Diversion Dam, Imperial, and Laguna. Morelos Diversion Dam, located just below the NIB is the last dam on the Colorado River. It is the operation of these dams and reservoirs, particularly Hoover Dam and Lake Mead, that determines the existing hydrology in the Lower Basin.

River stage (water levels) depends on the volume of water moving through the river at any particular location and point in time. Dam releases are made by Reclamation according to operational policies. In addition to the daily variations in river stage, there are seasonal and annual variations due to rainfall and reservoir releases. For example, the difference between maximum and minimum monthly stage for an individual month from October 1988 to September 1999 ranged from 0.11 to 7.09 feet. Monthly flows throughout the same time period varied from 100 kaf to 1 maf. The comparison of water levels to daily or annual water volumes indicates that volumes may vary widely.

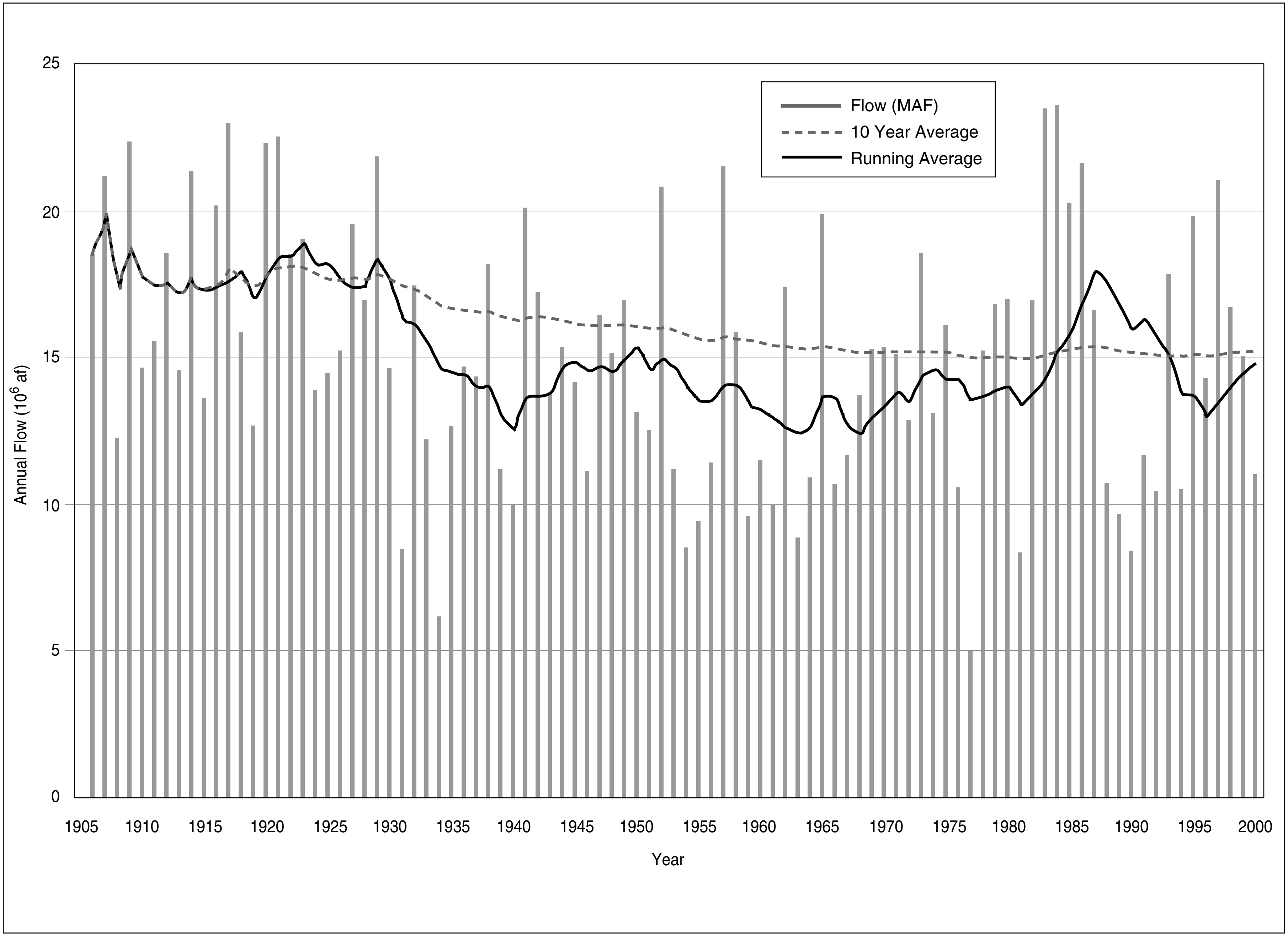

Figure 3.9-1. Natural Flows at Lees Ferry

Figure 3.9-2. Upper and Lower Basins of the Colorado River

There are a few lakes off the mainstem of the Colorado River that are affected by flow and surface elevations of the river. Cibola Lake, which is part of the Cibola NWR, has inlet and outlet control structures to maintain desired lake levels. Three Fingers Lake also has inlet and outlet control structures. Topock Marsh is also a regulated lake. Other lakes such as Adobe, Martinez, and Ferguson Lakes have no flow control structures, and water levels are dependent on levels of the river or reservoirs on the river.

Flooding on the LCR generally consists of two types of floods: large regional floods and localized floods. Large regional floods generally result from unusually high levels of snowmelt in the Upper Basin or in the Gila River watershed, resulting in basin-wide or regional increases in runoff. Localized floods result from localized, short-term flow increases from rainfall, including short-term winter rains, and summer thunderstorms, which can be intense over short periods. Operation of the facilities along the river is designed to maximize the storage of water for irrigation and water supply uses, and to provide flood control protection of downstream areas. Therefore, flood flows, which potentially "waste" water beyond the ability of local users to beneficially use it, are minimized. However, the ability to capture large flows downstream of Hoover Dam is limited due to the operation of Lake Mead and Lake Mohave and the limited storage capacity of other downstream reservoirs.

REACH 1

Glen Canyon Dam, which creates Lake Powell, is operated to make a minimum release of 8.23 maf annually, although releases can be greater.

Hoover Dam and Lake Mead are operated with the following three main priorities: (1) river regulation, improvement of navigation, and flood control; (2) irrigation and domestic uses, including the satisfaction of Present Perfected Rights (PPRs); and (3) electrical power production. The regulations set forth two primary flood control operations: (1) reserved floodwater space within Lake Mead, and (2) releases based on forecasted runoff. Lake Mead's uppermost 1.5 maf of storage capacity, between elevations 1219.6 and 1229 feet above msl, is allocated exclusively to control floods. Additional flood control space is required through the period August 1 through January 1. Normal space-building releases to create and maintain flood control space from August 1 to January 1 are limited to a maximum of 28,000 cfs. Between January 1 and July 31 flood control releases are based on forecasted inflow and can exceed 28,000 cfs.

Lake Mead provides the majority of the storage capacity for the Lower Basin. From 1980 to 2000 annual Lake Mead elevation ranged from 1,170 to 1,220 feet msl, a variation of 50 feet. The average annual elevation from 1990 to 1999 was 1,191 feet msl. Over a period of 3 years, from 2000 to 2003, Lake Mead elevations dropped more than 60 feet as a result of sustained drought in the western United States (NASA Earth Observatory 2003). In addition to flood control space, flood control releases are required when forecasted inflow exceeds probable available storage space at Lake Mead and Lake Powell, and allowable space in other Upper Basin reservoirs. This includes accounting for projected bank storage and evaporation losses at both lakes, plus net withdrawals from Lake Mead by water users. Releases are made in steps meant to retain power generation capacity and to protect the downstream river area.

Unless flood control releases are necessary, Hoover Dam is operated to meet downstream water demands, including the release of water for consumptive use by the Lower Division States plus the United States' obligation under the 1944 Water Treaty. Within these operations, Hoover Dam releases are managed on an hourly basis to maximize the value of generated power by providing peaking during high-demand periods. This results in fluctuating flows through Hoover Dam that can range from 1,000 cfs to 49,000 cfs. The upper value is the maximum flow-through capacity through the power plant at Hoover Dam (49,000 cfs). However, because these flows enter Lake Mohave downstream, the affected zone of fluctuation is only a few miles.

The close proximity of Lake Mohave to Hoover Dam effectively dampens the short-term fluctuations below Hoover Dam. Since 1980, annual releases from Lake Mead have varied from a low of 7.4 maf to a high of 21.4 maf. Daily releases can vary by more than 22,000 cfs. Since 1980, within any given non-flood year, flows through Hoover Dam have ranged from 750 cfs to 27,000 cfs.

Lake Mead is the primary water supply diversion point for the State of Nevada. About 90 percent of the state's 0.3 maf apportionment is diverted 5 miles northwest of Hoover Dam at SNWA's Saddle Island facilities. The minimum Lake Mead water level necessary to operate the pumping units at SNWA's original intake facility is 1,050 feet msl. SNWA recently constructed a second pumping plant and the minimum Lake Mead water level required to operate this unit is 1,000 feet msl. The new SNWA intake provides only a portion of the capacity required by SNWA to meet its Colorado River water supply needs. Therefore, the intake elevation of SNWA's original pumping plant is critical to its ability to divert its full Colorado River water entitlement.

In addition to SNWA's diversion, Basic Water Company also diverts water from Lake Mead at Saddle Island for use in the Henderson, Nevada area for industrial and domestic purposes.

Related to power generation and water supply, there are several "key" Lake Mead water surface elevations. The first elevation is 1,083 feet msl, the minimum elevation for the effective generation of power. The second elevation is 1,050 feet msl, the minimum elevation required for the operation of SNWA's original intake facility. The final elevation is 1,000 feet msl, the elevation required for operation of SNWA's second intake. Historic Lake Mead low water levels have dropped to the minimum rated power elevation of 1,083 feet msl during two periods (1954 to 1957 and 1965 to 1966). The highest historical Lake Mead water surface elevation of approximately 1,225.6 feet msl occurred once, in 1983.

REACHES 2 AND 3

Reach 2 of the planning area encompasses the land and waters within the historic floodplain between Hoover Dam and Davis Dam. Reach 3 extends from Davis Dam to Parker Dam. Major features between Hoover Dam and Parker Dam include Davis Dam, Havasu NWR and the Bill Williams River. Immediately downstream of Hoover Dam, river flows consist almost entirely of water released from Lake Mead. Between Davis and Parker dams minor gains in the river come from tributaries such as the Bill Williams River, groundwater discharge, and return flows from agriculture.

Daily and hourly releases from Hoover Dam reflect the short-term demands of Colorado River water users having diversions located downstream, storage management in Lake Mohave and Lake Havasu, and power production at Hoover, Davis, and Parker dams. Reclamation combines the total estimated water releases of Davis Dam and the target Lake Mohave elevation to determine the monthly amount of water required downstream of Hoover Dam. This monthly release is formulated into a monthly energy figure for Hoover Dam. The monthly energy figure is used by the Western Area Power Administration to meet the daily energy requirements of the electric service customers.

The primary purpose of Davis Dam is to re-regulate Hoover Dam releases to meet downstream needs and aid the annual delivery of 1.5 maf to Mexico. Releases at Davis Dam are scheduled on a daily basis to meet the water demands downstream and Lake Havasu storage management. The hourly release profile is determined by the electric service customer requirements, the current downstream river needs, and upstream Lake Mohave requirements. Since 1980, annual release from Davis Dam has varied from a low of 7.3 maf to a high of 21.7 maf (USBR 2000d).

Parker Dam's primary purpose is to provide reservoir storage from which water can be diverted into the Colorado River Aqueduct (CRA) and the Central Arizona Project (CAP) Aqueduct. The CRA delivers water to metropolitan Los Angeles and San Diego areas. The CAP delivers water to cities, industries, Indian communities, and agricultural areas in central and southern Arizona, including the Phoenix and Tucson areas. Parker Dam also has a power plant function and may provide a minimal amount of flood control, capturing and delaying flash floods into the river from tributaries below Davis Dam. Parker also re-regulates water released from the Hoover and Davis power plants, thus regulating river flow for downstream irrigators. Releases at Parker Dam are scheduled on a daily basis to meet the short-term demands of Colorado River water users located downstream. The hourly release profile is determined by the electric service customer requirements.

REACHES 4 AND 5

Major features between Parker and Imperial dams include Headgate Rock Dam and CRIT Diversion, Palo Verde Diversion Dam, and Cibola and Imperial NWRs. This stretch of the river is designated as Reaches 4 and 5. Reach 4 extends from below Parker Dam to the Cibola Gage; Reach 5 extends from the Cibola Gage to Imperial Dam.

Flows between Parker Dam and Palo Verde Diversion Dam result primarily from releases from Parker Dam. Since 1980, annual releases from Parker Dam have ranged from a low of 5.5 maf to a high of 20.5 maf. These releases are adjusted daily to meet the water demands of downstream users unless flood control releases are being made. These releases are further regulated within the day to maximize power generation. Within a given month, daily releases can vary by more than 11,000 cfs. Since 1980, within any given non-flood year, flows through Parker Dam on a daily basis have ranged from approximately 1,500 cfs (with a minimum of 30 cfs during an emergency situation) to approximately 19,500 cfs.

Annual surface water flow in the river, measured just downstream from Parker Dam, averaged approximately 9.0 maf for the period from 1935 to 1999, but varied from a maximum of approximately 20.5 maf to a minimum of approximately 5.5 maf (USGS 2003d). Annual median flow in the river over this same time period was approximately 7.3 maf (USGS 2003d). From 1990 to 1999, annual flow averaged 7.4 maf downstream from Parker Dam, and annual medial flow was 7.2 maf (USGS 2003d). The overall effect of diversions, local surface inflows, evapotranspiration, and groundwater recharge, is a decrease in flow between Parker and Imperial dams. Long-term average annual flow just upstream of Imperial Dam from 1935 to 1999 was approximately 8.1 maf (USGS 2003d). From 1990 to 1999, the average annual flow just upstream of Imperial Dam was 6.2 maf (USGS 2003d).

Palo Verde Diversion Dam is the intake for California's PVID. Flows between Palo Verde Diversion Dam and Imperial Dam are set by downstream demands and required deliveries to Mexico. Imperial Dam is the diversion point for the All American Canal (AAC), Yuma Main Canal, and the Gila Gravity Main Canal. The AAC delivers to California's Yuma Project Reservation Division, the Imperial Irrigation District (IID), and the Coachella Valley Water District. The Yuma Main Canal delivers to Arizona's Yuma Project, while the Gila Gravity Main Canal delivers to Arizona's Gila and Wellton-Mohawk projects.

The surface water levels in the Parker to Imperial dams reach of the Colorado River have daily variations, with a higher volume usually released from the reservoirs during the day. Just downstream of Parker Dam, the typical daily variation is about 5 feet in the summer when irrigation demand is high. In winter the daily variation in surface water levels is reduced to about 2.5 feet due to lower irrigation demand and a more consistent demand in general. By the time water reaches Imperial Dam, fluctuation is dampened to approximately 0.5 feet by the channel storage and daily variations in river surface water levels (USBR and IID 1994).

REACH 6

Reach 6 extends from Imperial Dam to the NIB. The major feature from Imperial Dam to the NIB is Laguna Dam. The Gila River enters the Colorado River system in this reach.

REACH 7

Reach 7 of the LCR extends from the NIB to the SIB, a distance of 23.1 miles that forms the boundary between Arizona (United States) and Baja California (Mexico). The major feature in this reach is Morelos Diversion Dam, located just downstream of the NIB. Mexico diverts the majority of its Colorado River water supply at Morelos Diversion Dam. Flows in this reach of the river vary. At times the lower part of this reach is dry. Cohen and Henges-Jeck (2000) reported average total flows in this reach of 22,000 af in non-flood years and 2,120,000 af in flood years. These flows are the result of seepage from Morelos Diversion Dam, flow releases from Morelos Diversion Dam (flood flows and excess water not diverted by Mexico), irrigation return flows from Mexico, canal wasteways in the United States, and groundwater accumulation from both the United States and Mexico.

THE REPUBLIC OF MEXICO

The 1944 Water Treaty provides Mexico with a right to receive 1.5 mafy plus 0.2 maf of surplus water, when available. Mexico received 1.7 maf in compliance with the treaty in both 1999 and 2000 (USBR 1999). The two governments through the International Boundary and Water Commission (IBWC) jointly administer the terms of the 1944 Water Treaty relating to the Colorado River. The operations are performed in collaboration with Reclamation. The deliveries to Mexico are jointly monitored by the IBWC to ensure compliance with the treaty allotment and schedules.

Groundwater

The Colorado River is in hydraulic connection with the groundwater in the underlying alluvium. Depending on river stage and groundwater elevations, the river can receive inflows from the aquifer, or it can provide recharge to the aquifer. The hydraulic connection results in groundwater levels that, at least in part, reflect the stage of the Colorado River.

Groundwater pumped from the underlying alluvium is considered Colorado River water and is accounted for under each states' apportionment. This includes groundwater pumped from the LCR floodplain and from certain wells on the alluvial slopes outside the floodplain. Reclamation, in association with the U.S. Geological Survey (USGS), has developed a method to identify wells outside of the floodplain that yield water that would be replaced by water from the Colorado River. This method has resulted in the development of an "accounting surface," or area where groundwater extractions are considered Colorado River water.

Studies using near-river (within 400 feet) observation wells in the Yuma area that were conducted in the 1970s showed the influence of river surface water levels on near-river groundwater elevations in an area irrigated with surface-diverted Colorado River water. The Yuma area near-river groundwater level changes in response to river level changes are considered to be representative of the groundwater response in the valleys below Parker Dam because of similar geohydrology. It is estimated that for every unit drop in river surface water levels, groundwater under irrigated fields closest to the river will drop by half a unit. In a non-irrigated reach, groundwater elevation drop is assumed to be equal to the river drop (USBR 2000d). Near-river groundwater elevations above Parker Dam may show differing responses to changes in river surface water levels.

NEVADA

Groundwater basins proximal to the river and within the accounting surface include those in the Las Vegas Wash Valley, other small drainages adjacent to Lake Mead, the smaller washes and drainages adjacent to Lake Mohave, and those in the areas of Laughlin and the Fort Mojave Indian Reservation. These basins are generally small in size and are bounded by zones of non-water bearing rock.

CALIFORNIA

Groundwater basins proximal to the river and within the accounting surface include portions of the Needles Valley, the Chemehuevi Valley, the Arch Creek and Vidal Wash area, the Big Wash and Slaughter Wash areas just north of the Palo Verde Valley, the Palo Verde Valley, Chuckwalla Valley, the Cibola Valley, Senator Wash, and the Yuma Valley. With the exception of the Yuma Valley, these basins are generally small in size and are bounded by zones of non-water bearing rock. For most of the basins, designated beneficial uses include municipal, industrial, and agricultural uses.

ARIZONA

Groundwater basins proximal to the river and within the accounting surface include the smaller washes and drainages adjacent to Lake Mead and Lake Mohave, portions of the Mohave Valley and Sacramento Wash, the smaller washes and drainages adjacent to Lake Havasu, portions of the Cactus Plain and the area around Parker, the Parker Valley, the Palo Verde Valley, Cibola Valley, the Yuma Valley, and the South Gila Valley. With the exception of the Yuma Valley, these basins are generally small in size and are bounded by zones of non-water bearing rock.

Water Quality

SURFACE AND GROUNDWATER CONSTITUENTS OF CONCERN

Salinity. The main water quality concerns for the lower portion of the Colorado River are associated with salinity and total dissolved solids (TDS)[1]. Factors influencing salinity levels include regional geology, salinity levels in tributaries and other inflow sources, drainage from irrigation system return flows, municipal discharge, and concentration of salts due to evaporation and other losses. Approximately 47 percent of the salinity in the Colorado River System is from natural sources (U.S. Department of the Interior [DOI] 1999). The remaining 53 percent is due to human activities including agricultural runoff, as well as industrial and municipal sources. The river increases in salinity from its headwaters to its mouth.

In 1974, the Colorado River Basin Salinity Control Act was enacted with the purposes of (1) resolving salinity issues associated with 1944 Water Treaty deliveries; and (2) creating a salinity control program within the United States portion of the Colorado River Basin to meet objectives and standards set by the CWA. The Federal/state salinity control program under Title II of the Salinity Control Act is designed to maintain flow-weighted average annual salinity at or below the adopted numeric criteria. The program is not intended to counteract short-term salinity variations due to the highly variable flows caused by natural factors (DOI 2001).

The Colorado River Basin Salinity Control Forum reviews the water quality standards for the Colorado River every three years and makes revisions to accommodate changes occurring in the Basin. The most recent review was in 2002. At each triennial review, the current and future water uses are analyzed for their impact on the salinity of the Colorado River. An implementation plan is developed, which includes adequate salinity control projects to assure compliance with the numeric criteria. In selecting a project, considerable weight is given to the relative cost-effectiveness of the project. Environmental feasibility is also considered.

Salinity is a Federal issue below Imperial Dam. Per United States Section, IBWC (USIBWC) Minute 242 of the 1944 Water Treaty, the United States must deliver water to Mexico at the NIB with an average annual salinity concentration no greater than 115 parts per million (ppm) (equivalent to 115 milligrams per liter [mg/L]) +/- 30 ppm (30 mg/L) over the average annual salinity concentration of the river at Imperial Dam.

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1 TDS is a measure of the total amount of minerals, organic matter, and nutrients that are dissolved in water. The dissolved solids concentration commonly is called the water's salinity and is classified as follows: fresh, 0-1,000 milligrams/Liter (mg/L); slightly saline, 1,000-3,000 mg/L; moderately saline, 3,000-10,000 mg/L; very saline, 10,000-35,000 mg/L; and briny, more than 35,000 mg/L.

Selenium. Selenium in the Colorado River naturally originates from shale sediment deposits along river tributaries. Within the river system, Lake Powell has the highest annual loading of dissolved selenium, and the majority of selenium is thought to come from above Lake Powell. Selenium loads drop within Lake Powell and drop again as the Colorado River passes through downstream reservoirs. Due to this decline, it does not appear that selenium is added to the system in the Lower Basin (DOI 1999). Research indicates that there are no local sources of selenium within the LCR basin, and, unlike in the Upper Basin, use of water for agricultural purposes along the LCR does not contribute to selenium increases (Radtke, et al. 1988). Selenium levels in biota of the Lower Basin have been found to equal or exceed the guideline for reproductive impairment of biota (Radtke, et al. 1988). Based on a recent study, selenium appears to be a constituent of concern in the LCR aquatic system, and continued selenium loading to the LCR could severely affect important components of the ecosystem (Radtke, et al. 1988).

Perchlorate. Ammonium perchlorate, the most common form of perchlorate contamination, is manufactured for use as an oxygen-adding component in solid propellant for rockets, missiles, and fireworks (EPA 1999, 2001). Perchlorate contamination in surface waters has been given increasing scrutiny due to potential health effects on human thyroid function (EPA 1999, 2001). There is currently no Federal National Primary Drinking Water Regulation for perchlorate. Perchlorate is on the EPA's Safe Drinking Water Act's Contaminant Candidate List as of 1998 (EPA 1999, 2001) and the EPA has established 1 part per billion (ppb) as the provisional reference dose for adults (EPA 1999, 2001; CADHS 2001).

Perchlorate has been detected in the water of the Colorado River and Lake Mead. Perchlorate concentrations have ranged from less than 4 ppb to 17 ppb at the SNWA's water intake at Lake Mead (EPA 1999, SNWA 2003b). The EPA identified two facilities in Henderson, Nevada that manufactured ammonium perchlorate and were found to have released perchlorate to groundwater. Kerr-McGee Chemical Company, the Nevada Department of Environmental Protection (NDEP) and Reclamation are working together to intercept a major surface flow of perchlorate-laden water along Las Vegas Wash. This program is ongoing and has significantly reduced the amount of perchlorate entering the Las Vegas Wash, Lake Mead, and the Colorado River. This remediation program will continue into the future and will continue to reduce perchlorate contamination in groundwater and in Colorado River water in Lake Mead and downstream (USBR 2000b).

Chromium 6. A plume of the chemical chromium-6 in groundwater near Needles, thought to be related to Pacific Gas and Electric operations in the area, has been observed moving toward the Colorado River (Coachella Valley Desert Sun 2003). Affected parties and the Colorado River RWQCB are currently exploring containment and cleanup options.

DESIGNATED IMPAIRED RIVER SEGMENTS AND WATER BODIES

Under section 303(d) of the CWA, the states and EPA identify "impaired" stream segments and water bodies where constituent concentrations impair the designated beneficial uses of the water body. Additional human activities within the segments, or that may directly or indirectly affect these segments, may result in further impairment. The states and EPA work together to develop a Total Maximum Daily Load (TMDL) for the segment, and set up a timeframe for reducing concentrations of the constituents and bringing the impaired water body back to attainment.

Several stream segments within the project area are currently impaired for some beneficial uses as a result of elevated constituent concentrations, including the following:

- The Las Vegas Wash, which is tributary to Lake Mead and carries the drainage for all of the Las Vegas metropolitan area to Lake Mead. The wash is currently impaired as a result of high ammonia and phosphorus concentrations, and iron and total suspended solids (TSS) are also being investigated as impairments to beneficial uses.
- The Colorado River between Hoover Dam and Lake Mohave, which has elevated pH levels. However, since the adoption of the 2002 303(d) List, the State of Nevada has updated its pH criteria and these areas are meeting the revised criteria (personal communication, R. Paul 2003). It is anticipated that these area will be reevaluated and removed from the 303(d) List as part of the 2004 303(d) List revisions (EPA 2003a).
- The Palo Verde Outfall Drain, which carries runoff from PVID to the Colorado River. Pathogenic bacteria from natural background sources and dysfunctional septic systems have resulted in the loss of beneficial uses of this water body (CRWQCB 2003).

The complete listing of impaired stream segments is presented in Table 3.9-1. Information included in this table provides a complete overview of constituents of concern in the potentially affected water bodies. However, the concentration and total load of these constituents of concern would not be affected by the Conservation Plan because the constituents of concern are primarily a result of urban, agricultural, and mining activities. The Conservation Plan would not increase or otherwise affect urban, agricultural, and mining activities in the planning area.

3.9.1.2 Muddy River/Moapa Valley and Virgin River

Surface Water

The Muddy River is a perennial river fed by the Muddy Springs in southern Nevada and flows into Lake Mead. The majority of the flow currently is used for agriculture and power generation (SNWA 2003a). The drainage area of the river is large, but due to soil conditions and rainfall patterns, only a small portion of the overall basin contributes directly to surface runoff (USGS 2003a). Near Moapa, the Muddy River recently exhibited a daily average flow of 30 cfs, part of a long-term downward trend from an average of 50 cfs in 1950 (USGS; period 1950-2000). Peak flows reached great than 1,000 cfs, while minimum flows were near 20 cfs.

The Virgin River originates in southwestern Utah, flows through the northwestern corner of Arizona and into Nevada where it joins the Colorado River at Lake Mead. Virgin River water is used for both domestic and agricultural uses. Stream flows in the lower Virgin River are frequently at or near zero, with an upper range of greater than 7,000 cfs occasionally exhibited. The normal range of measured flows tops out near 2,000 cfs, however.

Table 3.9-1. Impaired Water Bodies in the Project Area

Water Body	*Constituent(s) of Concern*	*Source*	*Proposed TMDL Completion*
CALIFORNIA			
Palo Verde Outfall Drain	Pathogens	Unknown	2003
ARIZONA [1]			
Virgin River	Fecal coliform and turbidity	Not identified	Not developed
Alamo Lake	Sulfide, pH, DO, and mercury	Assumed to be mining wastes	Not developed
Painted Rock Lake (Borrow Pit)	Fecal coliform, DO, and pesticides	Not identified	Not developed
NEVADA			
Las Vegas Wash – Telephone Line Road to Lake Mead	Total ammonia, total phosphorus, total iron, total suspended solids	Effluent discharges, nonpoint source runoff	TMDLs exist for ammonia and phosphorus; others not developed
Colorado River – Lake Mohave inlet to California state line	pH	Not identified	Not developed
Colorado River – Hoover Dam to Lake Mohave inlet	pH	Not identified	Not developed
Muddy River – Source to Glendale [2]	Total iron, total phosphorus, and temperature	Not identified	Not developed
Muddy River – Glendale to Lake Mead	Total boron, total iron, and temperature	Not identified	Not developed
Virgin River – Mesquite to Lake Mead	Total boron, total iron, total phosphorus, and temperature	Not identified	Draft in review – date uncertain
Virgin River – Stateline to Mesquite [2]	Total boron, total iron, total phosphorus, total nitrogen, and temperature,	Not identified	Not developed

Sources: State Water Resources Control Board (SWRCB) 2003, ADEQ 2002, Colorado RWQCB 2003, NDEP 2003

1 Impaired segments in Arizona are identified in the Lake Mead watershed, Bill Williams River watershed and the lower Gila River watershed, upstream from areas being evaluated as alternatives to the proposed action, that do not directly affect the mainstem Colorado River or occur within the riverine segments being evaluated as alternative conservation area establishment sites.

2 Some impaired segments in Nevada are identified in the Lake Mead watershed upstream from areas being evaluated as alternatives to the proposed action, that do not directly affect the mainstem Colorado River or occur within the riverine segments being evaluated as alternative conservation area establishment sites.

Groundwater

The surface water and groundwater basins designated along the Muddy and Virgin rivers in Nevada are part of Nevada's Hydrographic Region 13 (the Colorado River Basin hydrographic region). Both the Muddy River Springs/lower Moapa Valley and Virgin River Valley basins are classified as "designated[2]" for depleted groundwater conditions.

Water Quality

The Muddy River is designated as impaired under section 303(d) of the CWA over its entire length (see Table 3.9-1). The river is designated from its source to Glendale (13.63 miles) as impaired for iron (total), temperature, and total phosphorous. The TMDLs identified for this portion of the river have a priority of 3 (lowest). From Glendale to Lake Mead (25.07 miles) the river is listed for boron (total), iron (total), and temperature; iron and temperature were added in 2002. The TMDLs identified for this portion of the river have a priority of 3.

The reach of the Virgin River in Nevada from Mesquite to Lake Mead (25.75 miles) is designated as impaired under section 303(d) of the CWA for boron (total), iron (total), temperature, and total phosphorous; iron and temperature were added in 2002 (see Table 3.9-1). The TMDLs identified for this portion of the river have a priority of 3, with the exception of the boron, which has a priority of 1 (highest). From the Stateline to Mesquite (4.5 miles) the river is listed for boron (total), iron (total), temperature, and total nitrogen. The TMDLs identified for this portion of the river have a priority of 3, with the exception of the boron, which has a priority of 1. A Draft TMDL has been developed for boron (NDEP 2003a).

A portion of the Virgin River in Arizona is designated as impaired under section 303(d) of the CWA for turbidity and fecal coliform (see Table 3.9-1).

3.9.1.3 Bill Williams River

Surface Water

The Bill Williams basin consists of approximately 3,200 square miles. The Bill Williams River was historically a perennial stream, but flows in the river are now primarily dependent on the operation of Alamo Dam or on local precipitation. The Bill Williams River watershed area below Alamo Dam consists primarily of BLM and State of Arizona-owned lands, with a small percentage of private ownership. Many historic mining discharge permits have been granted in this watershed area.

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2 "Designated" groundwater basins are basins where permitted ground water rights approach or exceed the estimated average annual recharge and the water resources are being depleted or require additional administration. Under such conditions, a state's water officials will so designate a groundwater basin and, in the interest of public welfare, declare preferred uses (e.g., municipal and industrial, domestic, agriculture, etc.). For Nevada, in the interest of public welfare, the Nevada State Engineer, Division of Water Resources, Department of Conservation and Natural Resources, is authorized by statute (Nevada Revised Statute 534.120) and directed to designate a groundwater basin and declare preferred uses within such designated basin. The State Engineer has additional authority in the administration of the water resources within a designated groundwater basin.

Flows in the Bill Williams River are controlled primarily by releases from Alamo Dam. From 1988 to September 2002, the timeframe of daily stream flow data, flows were most frequently measured as zero (USGS 2003b). Some periodic daily average flows greater than 6,000 cfs were observed (USGS 2003b), probably as a result of local rainfall.

Groundwater

A hydraulic connection exists between flow in the Bill Williams River and groundwater in the alluvium along the river (ADWR 2003a). Short-term water level rises and declines of as much as 30 feet have been reported by well owners along the river. These fluctuations correlate with water releases at Alamo Dam.

Groundwater in the Bill Williams basin occurs in younger alluvial deposits, in basin-fill, and in fractured and porous volcanic rocks. The amount of water stored and extracted in each of these units varies, but the basin-fill contains the largest volume of stored water and is the primary water-bearing unit (ADWR 2003a). Recharge to the basin-fill results from stream flow infiltration and precipitation along the mountain fronts (ADWR 2003a).

Water Quality

There are no waters in the watershed below Alamo Dam that are listed on the section 303(d) CWA list. Alamo Lake, the source water for the Bill Williams River behind Alamo Dam, is currently under investigation for pH, DO, sulfide, and mercury. The impairment from mercury is possibly from mining activities in the watershed, and an investigation is in progress with ongoing sampling. There are no approved listings or implementation plans for this water body (ADEQ 2002). There are several riverine segments in the watershed above the lake that are impaired for various water quality attributes.

Water quality within the basin-fill is generally suitable for irrigation uses (ADWR 2003a).

3.9.1.4 Lower Gila River

Surface Water

The lower Gila River is ephemeral and flows only in response to precipitation events or water releases from upstream dams (ADWR 2003c). Prior to the construction of the Coolidge Dam, natural or unimpaired flow in the lower portion of the Gila River was intermittent (i.e., the river flowed for a few months or more, but did not flow year-round) (ADWR 2003c). Painted Rock Dam provides flood control on the lower Gila River. However, due the limited storage capacity on the river, this facility is not able to capture and or significantly moderate the large flood flow events (such as in the 1993 floods). Irrigation return flow from the Wellton-Mohawk Irrigation and Drainage District seeps into the Gila River channel near Dome, Arizona. This influx of water supports flow from Dome to the confluence with the Colorado River (ADWR 2003c).

Upstream of Dome, the river exhibits essentially no flow. Localized rainfall accounts for periodic daily average flows of up to 1,000 cfs. The area experienced significant flooding in 1993 following unusually prolonged rainfall. At the USGS gage near Dome, recorded daily mean flows exceeded 10,000 cfs on 83 days throughout the year, and exceeded 20,000 cfs on 27 days throughout the year (USGS 2003c). Peak flows in 1993 exceeded 28,000 cfs (USGS 2003c).

Groundwater

Groundwater in the lower Gila basin occurs in both the floodplain alluvium and the basin-fill. In the western part of the lower Gila basin (from approximately Dateland to Dome), groundwater development has occurred predominately in the streambed alluvium in the Gila River floodplain aquifer (ADWR 2003b). The primary water-bearing areas of the floodplain aquifer are the upper sandy unit and the lower gravel unit (ADWR 2003b). Groundwater in the floodplain aquifer is at a shallow depth and is unconfined. Groundwater development outside the Gila River floodplain is minimal and most of the wells outside the floodplain have low yields (ADWR 2003b).

Due to excessive recharge that resulted from the application of imported Colorado River water, a network of wells began pumping excess groundwater into drainage canals to lower shallow groundwater levels in the early 1960s (ADWR 2003b). These drainage canals discharge into the Colorado River at various points, or into Mexico. Since the early 1960s, groundwater pumpage in the western part of the basin has been primarily for drainage of excess irrigation water.

Water Quality

Painted Rock Lake (Borrow Pit) is designated as impaired under the section 303(d) of the CWA for DO, fecal coliform, and pesticides (see Table 3.9-1). Groundwater quality can vary substantially depending on the location within the basin, but in general, groundwater quality is poor in the Gila River floodplain due to high TDS concentrations (ADWR 2003b). Groundwater quality in the valleys and plains away from the Gila River floodplain is marginal to suitable, and TDS concentrations are generally lower than those observed in the floodplain.

3.9.2 Environmental Consequences

Significance Criteria

The proposed action would have a significant impact to water resources if it would:

- violate (or cause the violation of) any water quality standards or waste discharge requirement;
- substantially deplete groundwater supplies or interfere substantially with groundwater recharge or flow to the extent that it would not support existing land uses that rely on groundwater or planned uses for which permits have been granted;
- substantially alter the existing drainage pattern of the site or area, including the alteration of the course of a stream or river, in a manner which would result in substantial erosion or siltation on- or off-site;
- substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, or substantially increase the rate or amount of surface runoff in a manner which would result in flooding on- or off-site; or

- place within a 100-year flood hazard area structures which would impede or redirect flood flows.

3.9.2.1 Alternative 1: Proposed Conservation Plan

Impacts

The proposed action would require a water supply of approximately 57,400 af of water per year, or approximately 0.7 percent of the average annual water use within the Lower Basin from 1990 to 2001. As noted, in section 2.1.1.4, the legal structure governing the Colorado River would ensure that the proposed action would not increase the amount of water used in the Lower Basin beyond existing entitlements. The geographic scope of the proposed action would ensure that Colorado River water used as part of its implementation would be used within the historic floodplain of the LCR. The use of this water would not affect the water surface elevation of the LCR because it would be water that otherwise would be used for another purpose and would be diverted from the same general location. Moreover, the amount of water used would be small in comparison with the amount of water used within the Lower Basin and thus would not appreciably alter the water surface elevation even if it were not already being used for other purposes.

Conservation area establishment activities may require the construction of two field facilities, which would consist of a small, prefabricated steel building that would serve as an office and an equipment yard. They likely would be constructed on bare ground or at an already developed and graded site, and would require several acres at most. Fish rearing facilities also could be required. These structures would not be placed in areas where flood flows would be impeded or interrupted.

Conservation area establishment activities would require grading of both undeveloped and agricultural sites to provide suitable elevations for establishing habitat and to create access roads in some locations. Mounds and depressions would be created in order to provide micro-topographic diversity and simulate historic conditions. Backwaters also would be established and could result in the alteration of streams or rivers. None of these actions would substantially increase the rate or amount of surface runoff in a manner that would result in flooding on- or off-site.

The application of Colorado River water to conservation areas would not adversely affect local or regional groundwater levels or groundwater quality. Local groundwater levels may rise as a result of the periodic application of surface water to develop or maintain habitat, but the increase would be minor and temporary. The use of groundwater for irrigation purposes would be based on compliance with legal requirements for this use, so that there would be no adverse effect to groundwater resources. Moreover, water would not be applied to patches of established habitat in sufficient quantities to increase regional groundwater levels, particularly since they would be established in dispersed locations along the river, and irrigation would be required only at certain times of the year. Herbicides and pesticides would be applied periodically, but this would not affect groundwater quality since they would be applied in accordance with established requirements in the same manner as existing agricultural uses and would not be extensively used; it is likely that they would be applied in lesser quantities than used at existing agricultural sites that could be converted to other land cover types.

The use of Colorado River water as part of the proposed action would not adversely affect water quality except as discussed under **Impacts HYDRO-2** and **HYDRO-3** below. The potential for accidental releases of hazardous materials, which could have a minor, short-term, and localized effect on water quality, are addressed in section 3.8, Hazards and Hazardous Materials.

Impact HYDRO-1: Habitat establishment activities could result in erosion-induced siltation. Construction activities would include such actions as clearing vegetation, grading, excavating, dredging, stockpiling soil, construction/modification of supply canals, berm construction, and swale construction. Each of these activities could result in increased localized soil erosion and associated sedimentation of the Colorado River or backwaters. Less clearing and grading would be required if agricultural land were used instead of undeveloped land; erosion-induced siltation could occur, however, just to a lesser extent. The use of standard BMPs has been included as part of the proposed action (refer to section 3.0 for examples of typical BMPs), and could include constructing temporary pollution control measures such as silt fences and the application of straw and seed, minimizing the area to be cleared and graded to the extent possible, and installing barriers around stockpiled soil. Thus, with implementation of these BMPs, construction would not substantially alter the existing drainage pattern of the site in a manner that would result in substantial erosion or siltation on- or off-site. Impacts would be *less than significant.*

Impact HYDRO-2: Habitat establishment could have a short-term, adverse effect to water quality if irrigation resulted in the release of pesticides, salts, or other contaminants. This impact could occur if sites selected for the establishment of conservation areas contained contaminated soils. The release of herbicides and pesticides would be most likely to occur on sites that were previously used for agricultural activities. Increases in selenium levels in the LCR are not likely to be affected by irrigation of restoration sites due to the low levels of selenium in the soils. The release of other contaminants could occur on both undeveloped and developed sites. This, however, is highly dependent on the specific past history and other characteristics of the site and the type of conservation action implemented. In particular, the potency of many pesticides could have been reduced by naturally occurring physical and biological processes prior to their release by conservation actions. A number of other factors would further reduce the severity of potential impacts. Releases would be distributed throughout the planning area over the 20- to 30-year construction period. Further, once in the Colorado River, such releases would be diluted by the substantial flows ranging from more than 8 mafy in Reach 2 to 1.5 mafy in Reach 6. Impacts would be *less than significant.*

Salt leaching may be required on some sites prior to revegetation (primarily those sites that are not located on existing agricultural lands). This may require several applications of water throughout one or more growing seasons in order to create appropriate soil conditions. Because salt leaching would be a temporary activity and the amount of additional salts added to the Colorado River from this activity would be minor, impacts would be *less than significant*.

Impact HYDRO-3: Water quality in created or restored backwaters and marshes could be affected by increasing concentrations of various naturally occurring and man-made chemicals, including perchlorate, selenium, Chromium 6, and other dissolved salts (both in the soil and the water column) that result from evaporation of water. The proposed action includes the establishment of 360 acres of backwaters and 512 acres of marsh. The degree of connectivity to groundwater or the river would influence the extent to which salt or selenium concentrations increase. Marshes and backwaters with direct connection to the river do not tend to concentrate salts because the water flows through these systems, while those isolated from the river are more prone to salt concentrations due to high evaporation rates. High salinities reduce the water quality for both aquatic animals and plants and affect the composition of the community. The concentration of salts in water from isolated marshes and backwaters would not be not likely to reach the river unless water from these areas were pumped out as part of a "freshening" action. The amount of water returned to the river in this way would be small relative to the total flow, and the affected water would be diluted. Impacts to water quality would be *less than significant*.

Marshes and backwaters with direct connection to the river tend to have higher selenium levels than isolated marshes and backwaters. This is likely due to the inflow of selenium-bearing water to these areas, where it is available for capture in the organic sediments to move into the food chain. Isolated marshes and backwaters receive their water filtered through the ground, and it is believed this filtration removes selenium before the water reaches the marsh or backwater. Further investigations on this phenomenon are ongoing. High selenium levels have been implicated in reproductive failure in birds and fish, and these effects may be more likely to appear in connected marshes and backwaters than those isolated from the river. New, isolated marshes and backwaters are not likely to experience significant increases in selenium over time, or be a source of selenium concentration in the river. Impacts to water quality would be *less than significant*.

Impact HYDRO-4: Conservation area establishment would result in a long-term improvement to water quality if agricultural land were used. The conversion of agricultural land to riparian land cover types would lessen the input of nutrients and agricultural chemicals to the river, improving water quality and aquatic habitat conditions. The establishment of riparian vegetation along an expanded portion of the river would provide increased shading, water filtration, and nutrient and pollutant uptake, improving water quality and aquatic habitat conditions downstream. This impact would be *beneficial*.

Mitigation Measures

No mitigation measures are required because no significant impacts would occur.

Residual Impacts

Residual impacts are those that would occur after the implementation of mitigation measures to reduce an impact. No mitigation measures are required; thus, no residual impacts would occur.

3.9.2.2 Alternative 2: No Action Alternative

Under the no action alternative, it is likely that conservation measures similar to those included in the proposed action would be implemented since compliance with the ESA still would be required for the covered activities, although some conservation could occur in the off-site conservation areas (as described in section 3.9.2.4 below), as well as along the LCR. **Impacts HYDRO-1** through **HYDRO-4** apply to Alternative 2, as does the discussion of water surface elevation, flooding, groundwater, and water quality impacts from accidental spills in section

3.9.2.1. Water quality impacts associated with marsh creation along the lower Virgin, Muddy, and Bill Williams rivers would differ somewhat from those of the proposed action because different constituents of concern are present. Impacts would be *less than significant*, though, as described under **Impact HYDRO-3**. To the extent that the agencies undertaking the covered activities proceed with ESA compliance through section 7 consultations instead of the section 10 permitting process, there may be a reduced number of covered species because unlisted species would not be included. This would likely result in a smaller amount of conservation area being established and proportionately lessened impacts related to erosion-induced siltation and water quality from irrigation (**Impacts HYDRO-1** and **HYDRO-2**). It is likely that the amount of backwaters created would be similar to the proposed action since they provide habitat for listed species; thus, impacts associated with their creation would be as described for the proposed action (**Impact HYDRO-3**). The long-term improvement to water quality (**Impact HYDRO-4**) would be somewhat lessened under this alternative since less agricultural land would be converted to conservation areas under the worst-case scenario.

Mitigation Measures

No mitigation measures are required because no significant impacts would occur.

Residual Impacts

Residual impacts are those that would occur after the implementation of mitigation measures to reduce an impact. No mitigation measures are required; thus, no residual impacts would occur.

3.9.2.3 Alternative 3: Listed Species Only

Impacts HYDRO-1 through HYDRO-4 generally apply to Alternative 3, as does the discussion of water surface elevation, flooding, groundwater, and water quality impacts from accidental spills in section 3.9.2.1. This alternative would result in a smaller amount of conservation area being established and proportionately lessened impacts related to erosion-induced siltation and water quality from irrigation (**Impacts HYDRO-1** and **HYDRO-2**). The amount of backwaters created would be as described for the proposed action; thus, impacts associated with their creation would be as described for the proposed action (**Impact HYDRO-3**). The long-term improvement to water quality (**Impact HYDRO-4**) would be somewhat lessened under this alternative since less agricultural land would be converted to conservation areas under the worst-case scenario.

Mitigation Measures

No mitigation measures are required because no significant impacts would occur.

Residual Impacts

Residual impacts are those that would occur after the implementation of mitigation measures to reduce an impact. No mitigation measures are required; thus, no residual impacts would occur.

3.9.2.4 Alternative 4: Off-Site Conservation

As noted above, a hydraulic connection exists between flow in the Bill Williams River and groundwater in the alluvium along the river. The establishment of new habitat along the Bill Williams River on existing agricultural lands may result in an unquantified change in groundwater flow and availability for existing habitats downstream. The extent of change in groundwater flow would be dependent on the amount of water used to establish the new vegetation versus what is currently used for the agricultural operations. As described in section 2.1.4.2, LCR MSCP parties would obtain Bill Williams River water for implementing the Conservation Plan projects from various sources in accordance with Arizona law and in coordination with the Arizona parties to the LCR MSCP whose water rights may be affected by the use. The legal structure governing water rights within Arizona would ensure that the use of water under the proposed action would not increase the amount of Bill Williams River water used beyond existing apportionments. Through the use of water from these sources, implementation of the Conservation Plan would not increase the amount of water used from the Bill Williams River. Irrigating new habitat in this off-site conservation area could, however, result in a continuation of unquantified adverse impacts to groundwater flow to the existing habitats on Bill Williams River NWR resulting from the ongoing agricultural operations if the new habitat requires a similar amount of water as the ongoing operations. This would not result in an adverse impact to groundwater resources.

Impacts HYDRO-1, HYDRO-2, and HYDRO-4 generally apply to this alternative, as does the discussion of water surface elevation, flooding, groundwater, and water quality impacts from accidental spills in section 3.9.2.1. These impacts would be the same as described for the proposed action (*less than significant* or *beneficial*) since the same overall amount of conservation area would be established. Impacts from the establishment of cottonwood-willow, honey mesquite, and marsh would occur along the Muddy/Virgin, Bill Williams, and lower Gila rivers. **Impact HYDRO-3** also generally applies to this alternative. Water quality impacts associated with backwater development would be as described under **Impact HYDRO-3** because backwaters would continue to be established in the planning area. Water quality impacts associated with marsh establishment would be similar to those described under **Impact HYDRO-3,** although different constituents of concern are present along the Virgin, Muddy, and Bill Williams rivers (e.g., boron, iron, phosphorous, total nitrogen, and possibly mercury). As described under **Impact HYDRO-3**, for connected marshes, the extent of concentration of chemicals relative to the flow of the river is not likely to be significant. For isolated marshes, salts and selenium in those areas would not reach the river unless water from the area was pumped out as part of a "freshening" action. The amount of water involved relative to the flow of the river is small and the affected water would be diluted. Impacts to water quality would be *less than significant*.

Conservation area establishment would not affect the specific water quality parameters identified as impairing the use of the Muddy and Virgin rivers or Alamo Lake (refer to Table 3.9-1); thus, no additional water quality impacts would occur in these areas.

Along the lower Gila River, the proposed action could use groundwater as a water supply, but because the amount of water required is small, it would result in very minor, localized increases in the salinity of irrigation return water infiltrating to the local groundwater. Historic high groundwater levels have led to the installation of extensive dewatering networks in the region, and groundwater levels are closely controlled so that agriculture is not affected. The establishment of conservation areas along the lower Gila River would not exacerbate these high groundwater levels because the amount of water required would be small, and thus, water would not be applied to patches of established vegetation in sufficient quantities to increase regional groundwater levels. Additionally, conservation sites would be established in different locations along the river and irrigation would be required only at certain times of the year.

Mitigation Measures

No mitigation measures are required because no significant impacts would occur.

Residual Impacts

Residual impacts are those that would occur after the implementation of mitigation measures to reduce an impact. No mitigation measures are required; thus, no residual impacts would occur.

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